Applicants submit that a compound containing an "unsubstituted $NH_2$ group" defines a compound that contains a functional $NH_2$ group in which compound the $NH_2$ group is not substituted. A functional group is bonded and remains bonded in the compound that contains such a functional group. This can be readily understood by referring to a typical compound, for example, the compound $CH_3NH_2$ which contains an unsubstituted $NH_2$ group bonded to a methyl radical. In this connection, there is provided herewith a copy of page 177 from Morrison and Boyd, "Organic Chemistry", 3rd ed. containing the statement "The atom or group of atoms that defines the structure of a particular family of organic compounds and, at the same time, determines their properties is called the <u>functional group</u>" (original emphasis). And so it is in the present application where the presence of the unsubstituted $NH_2$ group defines those compounds that come within the penumbra of the claims.

Further attention is invited to paragraph 0019 on page 7 of the present application which describes the compounds containing an unsubstituted $NH_2$ group which expression is intended to also encompass salts of compounds having the $NH_2$ group. The feature of "unsubstituted" thereby clarifies that salts according to the present invention are compounds that have an "$NH_3^+$ group".

It is, therefore, respectfully submitted that the art recognizes the terminology used in the present application and consequently applicants believe that the record establishes that the terminology is not indefinite and does not render the claims improper under 35 U.S.C. § 112 (second paragraph).

The rejection of Claims 1 to 20 under 35 U.S.C. § 112 (first paragraph) as not being enabling for a compound containing an unsubstituted $NH_2$ group is traversed and reconsideration is respectfully requested.

As noted in the Official Action, page 7 paragraph 0019 provides a number of examples of compounds wherein the unsubstituted $NH_2$ group is directly bonded to a nitrogen or an oxygen atom. These compounds are representative of the group of compounds having an unsubstituted $NH_2$ group. Further, as explained in the application in paragraph 0019, all compounds that are suitable for the purposes of the present invention contain an unsubstituted $NH_2$ group which is capable of reacting with acetaldehyde at the conditions of distillation to form compounds with a boiling point higher than that of the propene oxide. With this information, together with the listing of the representative compounds, applicants submit they have provided a reasonable enablement for the claimed invention. Accordingly, it is applicants' position that the Official Action does not provide an adequate basis for rejecting the claims as lacking in enablement. See also, U.S. Patent 4,369,096 (copy enclosed), at col. 6, lines 35-col. 7, lines 1-16 for a very long list of such compounds which indicates that at least as of 1983, the art knew how to make and use such compounds.

The rejection of Claims 1 to 20 under 35 U.S.C. § 103(a) as being unpatentable over *Rueter, et al.* WO99/11639 or *Robeson, et al.* U.S. 2,622,060 in view of *Seifert, et al.,* EP 00,019 is traversed and reconsideration is respectfully requested. As noted in the Official Action, *Rueter, et al.* teach a process for separating crude epoxy reaction products which contain methanol and acetaldehyde using an extraction solvent of the same type claimed. The *Robeson* patent is relied on to show "an analogous process". The European document of *Seifert, et al.*

teach separating epoxidation reaction products using a solvent extraction process of the type recited in the claims by treating the reaction products with hydrazine. The Official Action admits that the *Rueter* and *Robeson* documents do not teach using hydrazine or hydroxylamine in the extraction process. *Seifert* is relied on in the Official Action to teach "an analogous extractive process" which treats the reaction products with hydrazine. In summary, the Official Action concludes that to modify *Rueter, et al.* and *Robeson, et al.* to include the addition of hydrazine as shown by *Seifert* to obtain "the cumulative purification effect" would have been obvious to one of ordinary skill in the art.

Applicants respectfully submit the combination of references fails to create *prima facie* obviousness of the claimed invention.

WO 99/11639, *Rueter, et al.* discloses a process for purification of propylene oxide by extractive distillation using an extractive solvent. The solvent is a compound that has one or more hydroxyl groups, as is disclosed on page 4, lines 16-30, and is used in amounts of at least 5 wt-% based on the raw propylene oxide product, as disclosed on page 5, lines 4-9. By means of extractive distillation water, methanol and part of acetaldehyde is separated from the propylene oxide product. As is evident from examples 1 and 2 removal of acetaldehyde is insufficient since the products contain 120 ppm and 406 ppm, respectively, of acetaldehyde. See page 9, line 23 and page 10, line 5. In contrast thereto, a commercially acceptable propylene oxide needs to have an acetaldehyde content of less than 100 ppm and preferably less than 20 ppm, as is disclosed on page 2, lines 2-5, of the same document. No disclosure is found in *Rueter, et al.* of the introduction into the distillation column of a compound containing an unsubstituted $NH_2$ group capable of reacting with any acetaldehyde present under the conditions of distillation.

The second primary reference, U.S. 2,622,060 to *Robeson, et al.*, discloses a process for purification of propylene oxide by means of extractive distillation whereby methyl formate is saponified to methanol and alkali metal formate. As is evident from the working examples, aqueous alkali solution is used in amounts of more than 50 wt-% of the raw propylene oxide product. Although this process allows substantial removal of methyl formate, the resultant propylene oxide nevertheless contains 4000 ppm acetaldehyde, as can be seen from example 2, and has to be distilled a second time in order to remove acetaldehyde, as disclosed in col. 4, lines 1-4, of that reference. No disclosure is found in *Robeson, et al.* of the introduction into the distillation column of a compound containing an unsubstituted $NH_2$ group capable of reacting with any acetaldehyde present under the conditions of distillation.

EP-A-004 019 or the equivalent U.S. patent 4,369,096, contrary to the Examiner's allegation, does not disclose an extractive distillation with a solvent, but instead shows a process which is an alternative to an extractive distillation. With respect to the disadvantages of extractive distillation *Seifert, et al.* (U.S. 4,369,096) refers explicitly to *Robeson, et al.*, see col. 2, line 7 *et seq.* Note the disadvantages mentioned by *Seifert, et al.* in col. 2, lines 11-26. See also, col. 4, lines 27-31.

The process of *Seifert, et al.* is based on the removal of the carbonyl compound using a chemical reaction between a compound with an $NH_2$ group and a carbonyl compound forming a condensation product. Thus, *Seifert, et al.* propose a method that is contrary to physical interaction that is the case when an extractive distillation is used. Solvents are thereby only employed by *Seifert, et al.* to dissolve the compound with the $NH_2$ group where the kind and amount of solvents employed for this purpose are not suitable in order to effect extractive

distillation. This is evident from the U.S. equivalent, col. 7, lines 41-54, and the working examples.

Consequently *Seifert, et al.* explicitly teaches to a person skilled in the art to use the process of *Seifert, et al.* ***instead of*** the process of *Robeson, et al.* Thus, a combination of the features of both processes is not suggested. On the contrary, *Seifert, et al.* would lead the skilled worker in the art away from the process disclosed in *Robeson, et al.*

Furthermore, *Seifert, et al.* discloses on col. 3, lines 43-68 to col. 4, lines 1-13 of the U.S. equivalent that by using an aqueous hydrazine solution the reaction with the carbonyl compounds is very slow and with acetaldehyde leads to unwanted insoluble products. *Seifert, et al.* thus teach away from using an aqueous solution of hydrazine for the purification of propylene oxide. Hence, it was not foreseeable from the teaching of *Seifert, et al.* that the process of the present invention using water as an extractive solvent (1.5 wt-% hydrazine in water) would be successful in obtaining the propylene oxide product without any problems with a low water content of 70 ppm (Example 1) and 50 ppm (Example 2), respectively, whereas the process of *Seifert, et al.* using hydrazine hydrate (64 wt-% hydrazine in water) in Example 3 results in a product with 200 ppm water.

Likewise, it was not foreseeable that the process according to the present invention compared with the teaching of *Rueter, et al.* leads to an improved removal of methanol resulting in a product with 36 ppm and 33 ppm, respectively, of methanol only, whereas by the process of *Rueter, et al.* products with 300 ppm and 1500 ppm, respectively, of methanol are obtained.

The Examiner's allegation that a person skilled in the art could expect a cumulative purification effect by the addition of hydrazine to the process of *Rueter, et al. or Robeson, et al.* is clearly contradicted by the teaching of *Seifert, et al.* in col. 3, lines 43-68 of the corresponding

U.S. patent that aqueous solutions of hydrazine only react slowly with carbonyl compounds and with acetaldehyde fouling of the evaporators will occur.

Consequently a person skilled in the art would not be lead to conduct the process of *Seifert, et al.* with diluted aqueous solution of hydrazine since he has to expect from the teaching of *Seifert, et al.* that no sufficient separation of carbonyl compound by chemical reaction will take place.

Furthermore, it should be taken into account that the purpose of the present invention is to obtain a pure propylene oxide with a very low methanol as well as very low aldehyde content. Even under the assumption of a cumulative purification effect when inadmissibly combining the teachings of *Rueter, et al.* or *Robeson, et al.* with *Seifert, et al.* it is a surprising technical result that in addition to a low aldehyde content by at least one magnitude, a lower methanol content, for example, compared to the *Rueter, et al.* reference, is achievable. Thus the present invention does not show merely a cumulative effect but instead demonstrates a synergistic effect that was by no means predictable from the cited prior art references.

In summary, the person skilled in the art first of all would not be lead to modify the processes of *Rueter, et al.* and *Robeson, et al.* by including the addition of hydrazine because *Seifert, et al.*, clearly teach the undesirability in col. 3, lines 43-68 to col. 4, lines 1-14 thereof in view of the slow reaction and fouling of equipment Furthermore, the person skilled in the art would not be lead by the teaching of *Seifert, et al.* to use an aqueous solution of hydrazine at all in order to remove aldehyde, especially acetaldehyde because *Seifert, et al.* teach that insufficient separation takes place. Finally a person skilled in the art could not predict that by the process of the present invention the methanol content of the final product can be reduced by at least an order of magnitude compared to *Rueter, et al.* since it is the clear teaching of *Seifert, et al.* that

the addition of an amino-functional compound has no influence on methanol at all but would only affect carbonyl compounds.

For the foregoing reasons, it is believed that the Official Action fails to establish a case of *prima facie* obviousness. Accordingly, applicants request withdrawal of the rejection and favorable action on the claims herein.

Respectfully submitted,

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(54) Verfahren zur Reinigung von Epoxiden.

(57) Die Erfindung betrifft ein Verfahren zur Reinigung von Epoxiden oder Epoxiden enthaltenden Gemischen, die bis zu 2 Gew.-% einer 1 bis 5 Kohlenstoffatome enthaltenden Carbonylverbindungen enthält, dadurch daß man das Epoxid in den mittleren Bereich einer Destillationseinheit einleitet, oberhalb des Zulaufs des Epoxid enthaltenden Produktstroms eine Verbindung, die ein oder mehrere unsubstituierte $NH_2$-Gruppen aufweist, einleitet und oberhalb der Einleitungsstelle dieser mindestens eine $NH_2$-Gruppe enthaltenden Verbindung in die Destillationskolonne das gereinigte Epoxid als Kopfprodukt oder als Seitenstrom abzieht.

EP 0 004 019 A2

Patentansprüche

1. Verfahren zur Reinigung von Epoxiden, dadurch gekennzeichnet, daß man das Epoxid oder ein Epoxid enthaltendes Gemisch, das, bezogen auf das Epoxid, bis zu 2 Gew.-% 1 bis 5 C-Atome enthaltende Carbonylverbindungen enthält, in den mittleren Bereich einer Destillationseinheit einleitet, oberhalb des Zulaufs des Epoxid enthaltenden Produktstromes eine Verbindung, die ein oder mehrere unsubstituierte $NH_2$-Gruppen aufweist, einleitet und oberhalb der Einleitungsstelle dieser mindestens eine $NH_2$-Gruppe enthaltenden Verbindung in die Destillationskolonne das gereinigte Epoxid als Kopfprodukt oder in einem Seitenstrom abzieht.

2. Verfahren nach Anspruch 1, dadurch gekennzeichnet, daß man eine Destillationseinheit verwendet, die einen Abtriebsteil mit 1 bis 50 theoretischen Trennstufen, einen Aufkonzentrierteil mit 1 bis 70 theoretischen Trennstufen, eine Verdampfereinheit und eine Kondensationseinrichtung enthält, wobei man zwischen dem Abtriebsteil und dem Aufkonzentrierteil das Epoxid oder das Epoxid enthaltende Gemisch, und 1 bis 20 theoretische Trennstufen oberhalb davon die mindestens eine freie $NH_2$-Gruppe enthaltende Verbindung einleitet und 1 bis 50 theoretische Trennstufen oberhalb der Einleitungsstelle das gereinigte Epoxid als Kopfprodukt oder in einem Seitenstrom abzieht.

3) Verfahren nach Anspruch 1 und 2, dadurch gekennzeichnet, daß man Äthylenoxid, Propylenoxid, 1,2-Epoxibutan, 2,3-Epoxibutan, Vinyloxiren oder Styroloxid oder ein Gemisch das eines dieser Epoxide enthält, wobei das Epoxid oder das Epoxid enthaltende Gemisch, bezogen auf das Epoxid, bis zu 2 Gew.-% 1 bis 5 C-Atome enthaltende Carbonylverbindungen enthält, einer Destillationseinheit zuführt, die aus einem Abtriebsteil mit 1 bis 20 theoretischen

*Third Edition*

# ORGANIC CHEMISTRY

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Chapter 6

# Alkenes II. Reactions of the Carbon–Carbon Double Bond

## Electrophilic and Free-Radical Addition

### 6.1 The functional group

The characteristic feature of the alkene structure is the carbon–carbon double bond. The characteristic reactions of an alkene are those that take place at the double bond. *The atom or group of atoms that defines the structure of a particular family of organic compounds and, at the same time, determines their properties is called the* **functional group.**

In alkyl halides the functional group is the halogen atom, and in alcohols the —OH group; in alkenes it is the carbon–carbon double bond. We must not forget that an alkyl halide, alcohol, or alkene has alkyl groups attached to these functional groups; under the proper conditions, the alkyl portions of these molecules undergo the reactions typical of alkanes. However, the reactions that are *characteristic* of each of these compounds are those that occur at the halogen atom or the hydroxyl group or the carbon–carbon double bond.

A large part of organic chemistry is therefore the chemistry of the various functional groups. We shall learn to associate a particular set of properties with a particular group wherever we may find it. When we encounter a complicated molecule, which contains a number of different functional groups, we may expect the properties of this molecule to be roughly a composite of the properties of the various functional groups. The properties of a particular group may be modified, of course, by the presence of another group and it is important for us to understand these modifications, but our point of departure is the chemistry of individual functional groups.

### 6.2 Reactions of the carbon–carbon double bond: addition

Alkene chemistry is the chemistry of the carbon–carbon double bond.

What kind of reaction may we expect of the double bond? The double bond consists of a strong $\sigma$ bond and a weak $\pi$ bond; we might expect, therefore, that